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APPARATUS FOR MAKING PRESTRESSED CONCRETE

Filed Aug. 17, 1964

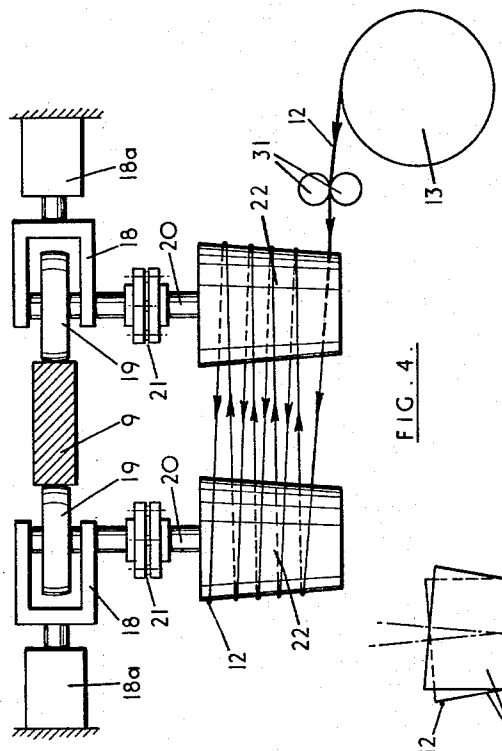


FIG. 4.

FIG. 3.

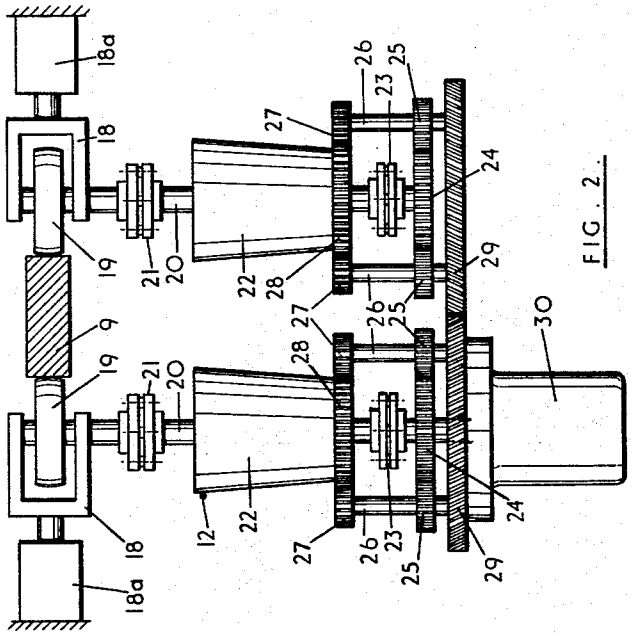


FIG. 2.

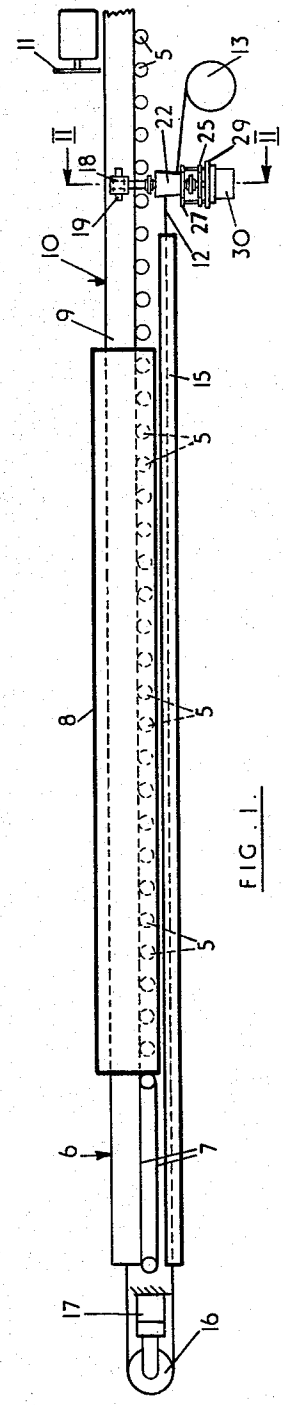


FIG. 1.

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APPARATUS FOR MAKING PRESTRESSED CONCRETE

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12 Claims. (Cl. 25—118)

This invention relates to prestressed concrete and in particular to apparatus for making same.

An object of the present invention is to provide an improved means for manufacturing prestressed concrete.

According to the present invention there is provided apparatus for making prestressed concrete comprising a stress bed on to which unhardened concrete is adapted to be fed, means for continuously feeding stressing wire over said bed so as to be surrounded by said concrete and embedded therein when the concrete has hardened, means for continuously applying a wire-tensioning load to said wire whereby the wire is maintained in a tensioned condition, and a fixed stress-compensating device included in said load-applying means and through which the wire is fed before passing to a movable member having a constant load applied thereto, said member be slidable relative to said stress-compensating device under the influence of said load to maintain constantly the wire under a given tension so that the reaction induced by the tension in the prestressing wire is transferred by the stress-compensating device to act in an opposite direction on the hardened concrete.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings in which:

FIGURE 1 is a diagrammatic side elevation of a prestressed concrete forming apparatus,

FIGURE 2 is a detail sectional view on the line II—II of FIGURE 1 illustrating a stress compensating device as employed in the arrangement of FIGURE 1,

FIGURE 3 is a diagrammatic view showing the disposition of the capstan members employed in the stress compensating device and

FIGURE 4 is a diagrammatic sectional view of an alternative form of stress compensating device to that shown in FIGURE 2.

Referring to FIGURES 1 to 3 of the drawings, apparatus for making prestressed concrete comprises a stress bed formed by a horizontal conveyor **5** made up of a plurality of spaced rollers arranged to receive from a moulding section **6** at its forward end a continuous supply of a concrete mixture. The forward end of the conveyor **5** is constituted by an endless belt **7**, which is driven at a constant predetermined rate in order to advance the moulded concrete in green form along the conveyor **5**. Surrounding the conveyor **5** for a substantial portion of its length is a concrete curing tunnel **8** and positioned above the stress bed at points subsequent to the emergency of the hardened concrete beam **9** from the tunnel **8** is a hardness testing device **10** for testing the hardness of the concrete and a flying saw **11** by means of which the beam can be cut into sections as desired. Steel wire **12** for creating the prestressed condition of the final concrete product is fed from a stock coil **13** and is passed over a stress compensating device shown generally at **14** in FIGURE 1 before passing through a wire pretreatment tunnel

15 located below the conveyor **5**. The treatment of the wire in the tunnel **15** consists in heating the wire at a temperature of 150–200° C. for a period of 7 to 8 hours during which time the tendency of the wire to "creep" owing to molecular deformation as a result of its being in a tensioned condition is accelerated. On leaving the tunnel **15** the wire **12** passes upwardly around a pulley wheel **16** before extending parallel to and above the conveyor **5** and at the same time passing through the moulding section **6** so that when the moulding section **6** is filled with concrete in green form the wire **12** within this section is surrounded by the concrete.

The pulley **16** is mounted so that its horizontal axis is slidable along a horizontal plane and movement of the axis of the pulley **16** can be effected by a hydraulic or pneumatic piston and cylinder device **17**. By control of the piston and cylinder device which applies a constant load to the pulley, the pulley **16** can be moved towards or away from the stress compensating device **14** in order to regulate the tension applied to the wire **12**. The application of this load on the pulley **16** acts to tension the wire **12** and results in a balancing of the reaction due to the tension in the stressing wire and leads to a reduction in power required to operate the system.

The stress tensioning device as shown in FIGURE 2 comprises a pair of brackets **18** resiliently loaded by loading members **18***a* and each of which brackets **18** carries a rubber-tyred roller **19** adapted to be urged by the loading on the brackets **18** into frictional engagement with the side faces of the hardened concrete beam **9** after its emergence from the curing tunnel **8**. Each rubber roller **19** carries a depending spindle **20** connected to the roller **19** through a flexible coupling **21**, the spindle **20** extending downwardly through a hollow capstan **22** before being connected through a second flexible coupling **23** to a gear wheel **24** carried on the lower end of the spindle **20**. Each of the gear wheels **24** is in mesh with a pair of planet wheels **25** mounted on vertical stub shafts **26** each of which shafts **26** carries at its upper end a second pair of planet wheels **27** in mesh with a gear wheel **28** secured to the lower end of each capstan **22**. The lower ends of the shafts **26** are mounted in one of a pair of meshing helically-toothed drive wheels **29** one of which is in driving relationship with an electric motor **30**. On operation of the electric motor **30** the drive wheels **29** are rotated relative to the gear wheels **24** to cause rotation of the planet wheels **25** and **27** thereby rotating the gear wheels **28** secured to the capstans **22** to effect relative movement between the latter and the drive wheels **29**. Otherwise the drive wheels **29** and capstans **22** are effectively locked to each other and rotate in synchronism.

The motor **30** is operated when for example, due either to wear on the rubber rollers **19** or slip, more wire is being fed into the moulding section of the apparatus than is required by the concrete being produced. The motor is controlled by an electrical contact actuated by the position of the piston and cylinder device **17**. If more wire is being fed in than is required the constant load device constituted by the piston and cylinder **17** is automatically operated to cause the pulley **16** to be moved further away from the stress compensating device **14** to take up the slack in the wire. Such movement of the piston and cylinder device **17** is transmitted to the motor **30** of the stress compensating device to cause rotation of the capstans **22** at such a speed and such a direction as to compensate for the overfeeding of the wire.

The capstans **22** are provided with grooves (not shown) on their surface to provide guideways for the wire and as shown in FIGURE 3 the vertical axes of the capstans **22** are canted relative to each other so as to avoid the wire fouling against itself since it is wound round the capstans in figure of eight formation to an extent sufficient to ensure there is no slip. Also, the capstans **22** are of reducing diameter from top to bottom and since the wire is fed on to each capstan at its lower end, this feature together with the relative canting of the axes ensures that the wire is fed across to a new position on each capstan in turn and that the wire is fed upwardly on the capstans.

In an alternative form of compensating device as illustrated in FIGURE 4, like parts are designated by the same reference numerals as in the embodiment shown in FIGURE 3. In the arrangement of FIGURE 4 the spindles **20** from the rubber-tyred rollers **19** are directly connected to a pair of relatively canted capstans **22** and the wire **12** fed to the capstans **22** from a stock coil **13** is fed through a pair of motor-driven rolls **31**. The diameter of the capstans **22** in this case is less than the diameter of the rollers **19** by an amount sufficient to ensure that, if there was no slip on the capstans, the wire **12** is underfed to the rate at which the hardened concrete is fed out thereby providing a prestressed condition to the wire **12**.

In a manner similar to the arrangement of FIGURE 3, the rolls **31** are controlled electrically by an electrical contact actuated by the position of the piston and cylinder device **17**. In this way if wire is being overfed or underfed to the stress bed, this causes a corresponding movement in the pulley **17** due to the piston and cylinder device. This movement is transmitted to the motor driving the rolls **31** to decrease or increase respectively the rate of feed of the wire to the capstans **22**.

In operation of the apparatus as shown in the drawings, concrete in green form is fed through an extrusion machine (not shown) located in the moulding section of the stress bed to surround one or more wires **12** held under tension above the bed and passing through the moulds. By means of the endless belt **7** (FIGURE 1) the moulded concrete length together with prestressed wire is continuously moved along the length of the bed to be passed through the curing tunnel **8**. On emerging from the tunnel **8**, the hardened concrete is tested for hardness by the testing device **10** before the continuous length of concrete is severed into sections as desired by the flying saw **11**. It will be readily apparent that instead of the concrete in green form being passed through an extrusion machine located at the moulding section and the resultant continuous extruded length of prestressed concrete being cut into sections by the flying saw **11**, the green concrete can be passed into individual moulds at the moulding section and the wires between adjacent moulds cut by the saw **11**.

During the above-described process the prestressing wire **12** is being continuously fed from the stock coil **13**, over the stress compensating device **14**, through the pre-treatment tunnel **15**, over the pulley **16** before passing to the moulding section.

Although in the above-described embodiments a constant load is applied to the pulley **16** through a piston and cylinder device, it will be apparent that this load can be applied by any other suitable means e.g. by means of a suspended weight.

Also although for simplicity only one stressing wire **12** has been referred to in the above-described embodiments, it will be apparent that any convenient number of wires can be fed to the moulding section **6** in like manner.

By means of the present invention, an arrangement is obtained in which the prestressing loads in the reinforcing wire can be nearly balanced since the reaction of the prestressing force is taken back through the prestressing wire and not through the formed concrete in which the tensioned wire is incorporated the approximate balance is

achieved since the reaction force is transferred through the rollers **19** to act on the hardened concrete in a direction opposite to that of the prestressing force.

Further the present invention enables accelerated curing of the concrete by heating to take place without incurring stress force that occur in previously proposed methods of producing prestressed concrete units employing fixed anchorages for holding the reinforcing wires under tension during their manufacture.

What I claim is:

1. Apparatus for making prestressed concrete comprising a stress bed on to which unhardened concrete is adapted to be fed, means for continuously feeding stressing wire over said bed so as to be surrounded by said concrete and embedded therein when the concrete has hardened, means for continuously applying a wire-tensioning load to said wire whereby the wire is maintained in a tensioned condition, and a fixed stress-compensating device included in said load-applying means and through which the wire is fed before passing to a movable member having a constant load applied thereto, said member be slidable relative to said stress-compensating device under the influence of said load to maintain constantly the wire under a given tension so that the reaction induced by the tension in the prestressing wire is transferred by the stress-compensating device to act in an opposite direction on the hardened concrete.

2. Apparatus as claimed in claim **1**, in which the stress bed comprises a roller conveyor having a driven endless conveyor at its forward end, the endless conveyor serving to advance the concrete to be formed along the stress bed.

3. Apparatus as claimed in claim **1**, comprising a curing tunnel through which the formed concrete in green form and having the stressing wire embedded therein is adapted to be passed during its passage along the stress bed.

4. Apparatus as claimed in claim **1**, comprising means for pre-treating the stressing wire prior to being incorporated in the concrete by heating the wire to a sufficient extent to cause acceleration of the molecular deformation which occurs due to the wires being maintained under tension.

5. Apparatus as claimed in claim **4**, in which the wire pre-treating means comprises a heating tunnel located below the stress bed, a fixed compensating device through which the wire is fed before passing to a movable member having a constant load applied thereto, said member being slidable relative said stress-compensating device under the influence of said load to maintain constantly the wire under a given tension so that the reaction induced by the tension in the prestressing wire is transferred by the stress-compensating device to act in an opposite direction on the hardened concrete.

6. Apparatus as claimed in claim **1**, in which the movable member comprises a pulley mounted on a slidable axis.

7. Apparatus as claimed in claim **6**, in which the constant load is applied to the movable member by means of a piston and cylinder device.

8. Apparatus as claimed in claim **1**, in which the stress-compensating device comprises capstan means around which the wire is fed, said capstan means being adapted to feed the wire at a rate governed by the rate of production of prestressed hardened concrete from the apparatus.

9. Apparatus as claimed in claim **8**, in which the capstan means are connected to rollers arranged to engage and be rotated by the hardened concrete as it is fed along the stress bed, said rotational movement being transmitted to the capstan means to control the feeding of the wire, the rollers also serving to apply a force to the hardened concrete in its direction of travel through the apparatus which balances the reaction force induced by the tension in the prestressing wire.

10. Apparatus as claimed in claim **1**, comprising electrical means whereby movement of the movable member due to overfeeding or underfeeding of the wire causes actuation of the stress-compensating device to compensate for the overfeeding or underfeeding.

11. Apparatus as claimed in claim **8**, in which the capstan means comprises a pair of co-operating capstans around which the wire is fed in figure of eight formation.

12. Apparatus as claimed in claim **11**, in which the capstans are of increasing diameter from top to bottom and their axes of rotation are canted relative to each other to prevent fouling of adjacent runs of wire extending between the capstans.

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